- Batteries

In spite of the periodic attention given to electric vehicles, the basic technology used in standar automotive batteries hasn't changed much over the last ten or fifteen years. Still, it's sometime review basic technology, just to reaffirm the fundamentals.

A battery is a storage device that converts electrical energy supplied to it into chemical energy, at some later time, reverses the process to supply electrical energy to loads connected to it. Ir car or light truck, the electrical energy supplied to it is typically generated by an alternator. Al v regulator or electronic control circuit keeps the battery at the proper charge level, and regulate current from the alternator to the battery during vehicle operation.

Chemical Considerations

A battery stores electrical energy by converting it to a chemical potential. While the process sc complicated, you can understand its basics without a degree in chemical engineering. First, th have to understand how a typical automotive battery-called a lead-acid type-is constructed.

Inside the nonconductive case (usually polypropylene, plastic, or hard rubber) stands an altern of thing positive and negative plates called electrodes. Adjacent plates are electrically insulate other by microporous plastic separators.

The plates are immersed in an electrolyte (a liquid that contains chemicals that help it to condu current) that can pass through the semipermeable plate separators. In automotive batteries, th electrolyte is sulfuric acid, chemically designated H2SO4, dissolved in distilled water to form a solution.

Each plate consists of a grid filled with a metallic paste. In modern maintenance-free batteries grids are made of lead-calcium alloy. In older batteries with filler caps for replenishing electroly the plates were typically made of lead-antimony alloys instead of lead-calcium.

In either style, each positive-plate grid is filled with a lead dioxide paste (chemical formula: PbC dark brown). Each negative-plate grid is filled with sponge lead paste (chemical formula: Pb; c The positive plates are electrically linked by lug straps that ultimately connect to the positive te the battery, while the negative plates are tied together and connected electrically to the negativ terminal.

When the battery is connected to an electrical load, such as a vehicle's starter motor, or its ligh ignition circuit, a set of chemical reactions occur that generate a current (measured in amperes through the load to ground.

The result of these chemical reactions is that lead sulfate ($PbSO_4$) is formed at both the positiv negative plates, making them more alike. At the same time, the sulfate removed from the elec replaced by oxygen from the positive plate. The oxygen combines with the hydrogen from the the electrolyte to form water (H_2O), making the solution more dilute. The battery, under these is discharging; the voltage decreases continuously until it falls below a useful level.

When the battery is being charged, the flow of electrical current through it from an alternator or causes reverse chemical reactions to occur at both the positive and negative plates that restor chemical compositions and the chemical potential (energy) within the battery.

These discharging/charging cycles can be repeated over the over again with only extremely sn in battery output.

Voltage

The voltage generated when two dissimilar metals are immersed in an electrolyte is determine chemical composition of each plate, and the chemistry of the electrolyte. Submersing a lead d positive electrode and a pure lead negative electrode into a solution of sulfuric acid produces a electrical potential of 2.1 volts. Even if a number of positive plates are connected in parallel, ai number of negative plates are connected in parallel and both sets are immersed in an electroly voltage generated 2.1 volts, assuming the same materials are used. Only the current is affecte number of plates per cell.

In an automotive battery, a group of positive plates and negative plates immersed in one electr isolated section f sulfuric acid is called a cell. A typical automotive battery contains six separat electrically connected in series, so that the nominal voltage produced by the series is 12.6 volt:

Capacity Ratings

A battery's capacity-the amount of current it can generate-is determined by its construction-prir number of plates per cell and the total surface area of the active material (the paste) on each p a lesser degree, by the concentration and volume of the electrolyte, and permeability of the pla separators.

One battery rating, used for a number of years was ampere-hours, also called amp-hours, and abbreviated A-h. The test used to determine this rating was conducted by discharging a batter controlled laboratory conditions, starting with a new, fully charged battery.

The battery was discharged at a constant rate for 20 hours, at the maximum rate that would sti average voltage at a minimum of 1.75 volts per cell (10.5 volts total for a 12 volt battery). The figure was determined by multiplying the battery's current output by the 20-hour discharge time instance, if a battery generated an average of 3.5 amperes for the 20 hours of the test, its ratin 70 A-h. Today, two expressions of battery capacity are commonly used in the US. Cold crank amperes (CCA) defines the battery's ability to start the vehicle under extremely cold conditions short-term job). Reserve capacity (RC) defines the amount of time the battery can supply the \ electrical needs if the alternator/charging circuit should fail.

The CCA rating of a battery is the discharge rate (current, in amperes) that that battery is capa sustaining for at least 30 seconds at an ambient temperature of 0 degrees fahrenheit, without t voltage falling below 1.2 volts per cell (7.2 colts for a 12-volt battery). CCA Ratings fro car and batteries typically fall in the 400 to 950 range, though that range is by no means inclusive of all commercially available batteries.

Reserve capacity measures the time, in minutes, that a battery can sustain a current draw of 2 without the terminal voltage falling below 10.5 volts, at a temperature of 80 degrees fahrenheit. typically fall in the 60 to 125 range for automotive batteries. This means that a customer woulc about an hour or two to get home or to a place of safety after the charging system failed, if he (driving at night.

CCA ratings are the ones that are advertised most, and the ones that consumers are often mo: impressed by. Nonetheless, CCA ratings should not be the only consideration in making a bat recommendation.

With the number of electrical accessories installed on vehicles today that might be operated wl engine is off, reserve capacity can be an important consideration in battery selection.

Life Factors

In addition to adequate electrical performance, a battery must provide satisfactory physical per that is, it must remain intact under all normal se conditions, and provide an acceptable life, bas cost and warranty.

The battery case and its internal reinforcements must protect the plates from the harsh environ under the hood, while vibration, ambient temperature extremes, humidity, road-borne slats, coı mounting space, and high underhood operating temperatures all conspire to shorten a battery':

Physical damage-like vibration, impact, or severe overcharging-can end the life of a battery at separators are damaged, then cells can short out and voltage can fall below operable levels.

A faulty charging circuit, or improperly operated off-vehicle charging system can boil off a subs portion of the water in the electrolyte, even in a maintenance-free battery, again ending the bat prematurely.

Even when everything operates perfectly, though, a battery will eventually wear out. In every discharge/charge cycle, recovery is not actually 100%, but is something slightly less than that.

Very slowly, over time, the pastes on the positive and negative plates are dissipated. Some le: ($PbSO_4$) remains in the charged battery. Moreover, the positive plate is subject to corrosion. is a slow process, but one that invariably occurs. Ultimately, the battery's output will fall below required to star the vehicle. And that's when you are likely to see a new customer, asking you battery recommendation.

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